

AMENDMENTS TO THE CLAIMS

The claims in this listing will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1. (Currently Amended) A picture angle detection apparatus for detecting an angle of a picture related to a pixel to be interpolated in each interpolation scanning line between scanning lines based on an input video signal, comprising:

a binary pattern ~~generator~~ generator that binarizes said input video signal in a predetermined detection region including a plurality of scanning lines and said pixel to be interpolated to generate a binary pattern;

a reference pattern ~~generator~~ generator that generates binary pictures having different directions as a plurality of reference patterns;

a comparator that compares the binary pattern generated by said binary pattern ~~generator~~ generator with each of the plurality of reference patterns generated by said reference pattern ~~generator~~ generator to detect the angle of the picture related to said pixel to be interpolated based on a comparison result; and

a shape detector that detects the shape of the picture based on a combination of the angle of the picture detected by said comparator related to said pixel to be interpolated and angles of the picture detected in upper and lower interpolation scanning lines, and

when the angle of the picture detected by said comparator related to said pixel to be interpolated is between the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line, and the absolute

value of the angle of the picture detected in the upper interpolation scanning line is larger than the absolute value of the angle of the picture detected in the lower interpolation scanning line,

said shape detector outputs a shape detection signal indicating that the shape of the picture is convex toward the lower right, when the angle of the picture detected related to said pixel to be interpolated, and the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line are positive values, and said shape detector outputs a shape detection signal indicating that the shape of the picture is convex toward the lower left, when the angle of the picture detected related to said pixel to be interpolated, and the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line are negative values, and

when the angle of the picture detected by said comparator related to said pixel to be interpolated is between the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line, and the absolute value of the angle of the picture detected in the upper interpolation scanning line is smaller than the absolute value of the angle of the picture detected in the lower interpolation scanning line,

said shape detector outputs a shape detection signal indicating that the shape of the picture is convex toward the upper left, when the angle of the picture detected related to said pixel to be interpolated, and the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line are positive values, and said shape detector outputs a shape detection signal indicating that the shape of the picture is convex toward the upper right, when the angle of the picture detected related to said pixel to be interpolated, and the angle of the picture detected in the upper interpolation scanning

line and the angle of the picture detected in the lower interpolation scanning line are negative values.

2. (Cancelled)

3. (Currently Amended) ~~The picture angle detection apparatus according to claim 1,~~

A picture angle detection apparatus for detecting an angle of a picture related to a pixel to be interpolated in each interpolation scanning line between scanning lines based on an input video signal, comprising:

a binary pattern generator that binarizes said input video signal in a predetermined detection region including a plurality of scanning lines and said pixel to be interpolated to generate a binary pattern;

a reference pattern generator that generates binary pictures having different directions as a plurality of reference patterns;

a comparator that compares the binary pattern generated by said binary pattern generator with each of the plurality of reference patterns generated by said reference pattern generator to detect the angle of the picture related to said pixel to be interpolated based on a comparison result; and

a shape detector that detects the shape of the picture based on a combination of the angle of the picture detected by said comparator related to said pixel to be interpolated and angles of the picture detected in upper and lower interpolation scanning lines,

wherein when said shape detector detects that the shape of the picture is an arc, said detector outputs a shape detection signal indicating the direction of the inside of the arc.

4. (Currently Amended) ~~The picture angle detection apparatus according to claim 1,~~
A picture angle detection apparatus for detecting an angle of a picture related to a pixel to
be interpolated in each interpolation scanning line between scanning lines based on an input
video signal, comprising:

a binary pattern generator that binarizes said input video signal in a predetermined
detection region including a plurality of scanning lines and said pixel to be interpolated to
generate a binary pattern;

a reference pattern generator that generates binary pictures having different directions as
a plurality of reference patterns;

a comparator that compares the binary pattern generated by said binary pattern generator
with each of the plurality of reference patterns generated by said reference pattern generator to
detect the angle of the picture related to said pixel to be interpolated based on a comparison
result; and

a shape detector that detects the shape of the picture based on a combination of the angle
of the picture detected by said comparator related to said pixel to be interpolated and angles of
the picture detected in upper and lower interpolation scanning lines,

wherein said binary pattern ~~generater~~ generator comprises:

a threshold value calculation device that calculates a threshold value for binarization
based on the luminance of a video signal in said detection region; and

a binarizer that binarizes said input video signal using the threshold value calculated by
said threshold value calculation device to generate said binary pattern.

5. (Currently Amended) ~~The picture angle detection apparatus according to claim 1,~~
~~further comprising~~

A picture angle detection apparatus for detecting an angle of a picture related to a pixel to be interpolated in each interpolation scanning line between scanning lines based on an input video signal, comprising:

a binary pattern generator that binarizes said input video signal in a predetermined detection region including a plurality of scanning lines and said pixel to be interpolated to generate a binary pattern;

a reference pattern generator that generates binary pictures having different directions as a plurality of reference patterns;

a comparator that compares the binary pattern generated by said binary pattern generator with each of the plurality of reference patterns generated by said reference pattern generator to detect the angle of the picture related to said pixel to be interpolated based on a comparison result; and

a shape detector that detects the shape of the picture based on a combination of the angle of the picture detected by said comparator related to said pixel to be interpolated and angles of the picture detected in upper and lower interpolation scanning lines, and

a determining device that determines whether or not the luminance distribution in the horizontal direction of each scanning line is in the form of a monotonous increase or a monotonous decrease in the video signal in said detection region,

wherein said comparator does not compare said binary pattern with each of said plurality of reference patterns when said luminance distribution is neither in the form of a monotonous increase nor a monotonous decrease.

6. (Currently Amended) ~~The picture angle detection apparatus according to claim 1,~~
~~further comprising~~

A picture angle detection apparatus for detecting an angle of a picture related to a pixel to be interpolated in each interpolation scanning line between scanning lines based on an input video signal, comprising:

a binary pattern generator that binarizes said input video signal in a predetermined detection region including a plurality of scanning lines and said pixel to be interpolated to generate a binary pattern;

a reference pattern generator that generates binary pictures having different directions as a plurality of reference patterns;

a comparator that compares the binary pattern generated by said binary pattern generator with each of the plurality of reference patterns generated by said reference pattern generator to detect the angle of the picture related to said pixel to be interpolated based on a comparison result; and

a shape detector that detects the shape of the picture based on a combination of the angle of the picture detected by said comparator related to said pixel to be interpolated and angles of the picture detected in upper and lower interpolation scanning lines, and

a contrast detector that detects a contrast in a video signal in said detection region,
wherein said comparator does not compare said binary pattern with each of said plurality of reference patterns when the contrast detected by said contrast detector is smaller than a predetermined value.

7. (Currently Amended) ~~The picture angle detection apparatus according to claim 1,~~

A picture angle detection apparatus for detecting an angle of a picture related to a pixel to be interpolated in each interpolation scanning line between scanning lines based on an input video signal, comprising:

a binary pattern generator that binarizes said input video signal in a predetermined detection region including a plurality of scanning lines and said pixel to be interpolated to generate a binary pattern;

a reference pattern generator that generates binary pictures having different directions as a plurality of reference patterns;

a comparator that compares the binary pattern generated by said binary pattern generator with each of the plurality of reference patterns generated by said reference pattern generator to detect the angle of the picture related to said pixel to be interpolated based on a comparison result; and

a shape detector that detects the shape of the picture based on a combination of the angle of the picture detected by said comparator related to said pixel to be interpolated and angles of the picture detected in upper and lower interpolation scanning lines,

wherein the plurality of reference patterns each include a first pixel row arranged in a scanning line above said pixel to be interpolated and a second pixel row arranged in a scanning line below said pixel to be interpolated, and

wherein said first pixel row has one transition point from a first pixel value to a second pixel value, said second pixel row has one transition point from a first pixel value to a second pixel value, and the transition direction from the first pixel value to the second pixel value in said first pixel row and the transition direction from the first pixel value to the second pixel value in the second pixel row are the same.

8. (Currently Amended) A scanning lines interpolation apparatus, comprising:

a picture angle detection apparatus that detects the angle and shape of a picture related to a pixel to be interpolated based on an input video signal; and

an interpolation circuit that selects pixels to be used for interpolation based on the angle and shape detected by said picture angle detection apparatus, and calculates the value of said pixel to be interpolated using the selected pixels to generate an interpolation scanning line,

said picture angle detection apparatus including:

a binary pattern ~~generator~~ generator that binarizes said input video signal in a predetermined detection region including a plurality of scanning lines and said pixel to be interpolated in each said scanning line to generate a binary pattern;

a reference pattern ~~generator~~ generator that generates binary pictures having different directions as a plurality of reference patterns;

a comparator that compares the binary pattern generated by said binary pattern ~~generator~~ generator with each of the plurality of reference patterns generated by said reference pattern ~~generator~~ generator to detect the angle of the picture related to said pixel to be interpolated based on a result of comparison; and

a shape detector that detects the shape of the picture based on a combination of the angle of the picture detected by said comparator related to said pixel to be interpolated and angles of the picture detected in upper and lower interpolation scanning lines, and

when the angle of the picture detected by said comparator related to said pixel to be interpolated is between the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line, and the absolute value of the angle of the picture detected in the upper interpolation scanning line is larger than the absolute value of the angle of the picture detected in the lower interpolation scanning line,

said shape detector outputs a shape detection signal indicating that the shape of the picture is convex toward the lower right, when the angle of the picture detected related to said pixel to be interpolated, and the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line are positive values, and said shape detector outputs a shape detection signal indicating that the shape of the picture is convex toward the lower left, when the angle of the picture detected related to said pixel to be interpolated, and the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line are negative values, and

when the angle of the picture detected by said comparator related to said pixel to be interpolated is between the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line, and the absolute value of the angle of the picture detected in the upper interpolation scanning line is smaller than the absolute value of the angle of the picture detected in the lower interpolation scanning line,

said shape detector outputs a shape detection signal indicating that the shape of the picture is convex toward the upper left, when the angle of the picture detected related to said pixel to be interpolated, and the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line are positive values, and said shape detector outputs a shape detection signal indicating that the shape of the picture is convex toward the upper right, when the angle of the picture detected related to said pixel to be interpolated, and the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line are negative values.

9. (Currently Amended) ~~The scanning lines interpolation apparatus according to claim 8,~~

A scanning lines interpolation apparatus, comprising:

a picture angle detection apparatus that detects the angle and shape of a picture related to a pixel to be interpolated based on an input video signal; and

an interpolation circuit that selects pixels to be used for interpolation based on the angle and shape detected by said picture angle detection apparatus, and calculates the value of said pixel to be interpolated using the selected pixels to generate an interpolation scanning line,

said picture angle detection apparatus including:

a binary pattern generator that binarizes said input video signal in a predetermined detection region including a plurality of scanning lines and said pixel to be interpolated in each said scanning line to generate a binary pattern;

a reference pattern generator that generates binary pictures having different directions as a plurality of reference patterns;

a comparator that compares the binary pattern generated by said binary pattern generator with each of the plurality of reference patterns generated by said reference pattern generator to detect the angle of the picture related to said pixel to be interpolated based on a result of comparison; and

a shape detector that detects the shape of the picture based on a combination of the angle of the picture detected by said comparator related to said pixel to be interpolated and angles of the picture detected in upper and lower interpolation scanning lines,

wherein when said shape detector detects that the shape of the picture is an arc, said detector outputs a shape detection signal indicating the direction of the inside of the arc, and

wherein said interpolation circuit selects pixels to be used for interpolation from the inside of the arc based on the shape detection signal output from the shape detector and

calculates the value of said pixel to be interpolated using the selected pixels to generate an interpolation scanning line.

10. (Currently Amended) ~~The scanning lines interpolation apparatus according to claim 8,~~

A scanning lines interpolation apparatus, comprising:

a picture angle detection apparatus that detects the angle and shape of a picture related to a pixel to be interpolated based on an input video signal; and

an interpolation circuit that selects pixels to be used for interpolation based on the angle and shape detected by said picture angle detection apparatus, and calculates the value of said pixel to be interpolated using the selected pixels to generate an interpolation scanning line,

said picture angle detection apparatus including:

a binary pattern generator that binarizes said input video signal in a predetermined detection region including a plurality of scanning lines and said pixel to be interpolated in each said scanning line to generate a binary pattern;

a reference pattern generator that generates binary pictures having different directions as a plurality of reference patterns;

a comparator that compares the binary pattern generated by said binary pattern generator with each of the plurality of reference patterns generated by said reference pattern generator to detect the angle of the picture related to said pixel to be interpolated based on a result of comparison; and

a shape detector that detects the shape of the picture based on a combination of the angle of the picture detected by said comparator related to said pixel to be interpolated and angles of the picture detected in upper and lower interpolation scanning lines,

wherein when said shape detector detects that the shape of the picture is an arc, said detector outputs a shape detection signal indicating the direction of the inside of the arc, and

wherein said interpolation circuit selects positions shifted in the direction of the inside of the arc by 0.5 pixel from positions in the upper and lower scanning lines in the direction of the angle of the picture detected for the pixel to be interpolated and calculates the value of said pixel to be interpolated using the values of the pixels in the selected positions.

11. (Currently Amended) A picture angle detection ~~methods~~ method for detecting an angle of a picture related to a pixel to be interpolated in each interpolation scanning line between scanning lines based on an input video signal, comprising ~~the steps of~~:

binarizing said input video signal in a predetermined detection region including a plurality of scanning lines and said pixel to be interpolated to generate a binary pattern;

generating binary pictures having different directions as a plurality of reference patterns;

comparing said generated binary pattern with each of said generated plurality of reference patterns to detect the angle of the picture related to said pixel to be interpolated based on a comparison result; and

detecting the shape of the picture based on a combination of the angle of said detected picture related to said pixel to be interpolated and angles of the picture detected in upper and lower interpolation scanning lines, and

when the angle of the picture detected by the comparing related to said pixel to be interpolated is between the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line, and the absolute value of the angle of the picture detected in the upper interpolation scanning line is larger than the absolute value of the angle of the picture detected in the lower interpolation scanning line,

outputting a shape detection signal indicating that the shape of the picture is convex toward the lower right, when the angle of the picture detected related to said pixel to be interpolated, and the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line are positive values, and the outputting of the shape detection signal indicating that the shape of the picture is convex toward the lower left, when the angle of the picture detected related to said pixel to be interpolated, and the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line are negative values, and

when the angle of the picture detected by the comparing related to said pixel to be interpolated is between the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line, and the absolute value of the angle of the picture detected in the upper interpolation scanning line is smaller than the absolute value of the angle of the picture detected in the lower interpolation scanning line,

outputting a shape detection signal indicating that the shape of the picture is convex toward the upper left, when the angle of the picture detected related to said pixel to be interpolated, and the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line are positive values, and the outputting of the shape detection signal indicating that the shape of the picture is convex toward the upper right, when the angle of the picture detected related to said pixel to be interpolated, and the angle of the picture detected in the upper interpolation scanning line and the angle of the picture detected in the lower interpolation scanning line are negative values.